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Applied physics in GPON network technology...A new era of telecommunications

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ABSTRACT

The need for a fast internet access, as well as other services, in the area of telecommunications has imposed applications of multiplexing channels and broadband networks implementation. The entire industry of cable systems in the world has already been at a high level, so the operators in the region could find technical solutions rather easily, provided that they have a good financial support. In time, operators realized the gravity and capacity of services, so they started introducing professional equipment made by renowned manufacturers and setting up a completely new infrastructure with far better technical characteristics by installing active broadband equipment that enables the construction of a large and quality infrastructure. Building such networks started by applying the HFC configuration logic. Passive system components with completely new technical characteristics were built in the entire infrastructure which contributes to the service quality.

Keywords: Internet, GPON networks, systems.

Introduction

It is increasingly resorted to building and installing optical threads / fibres (glass fibres), the technology of distributing information and data through a controlled medium - glass thread by using light signals, which is a direct application of the basic laws of physics, i.e. the branch of optics, the discovery of the dual nature of light (corpuscular and wave - motion), the photoelectric effect and discovery of the laser, with the goal of approaching the end user with this infrastructure.

The new generation of telecommunications infrastructure is currently reflected in the installation of GPON networks. GPON are passive optical networks with large capacities that use an optical thread / fibre to connect with the end user, where the only active system equipment is partly situated with the end user and partly at the operator's main station, and all other infrastructure consists of passive components. This type of architecture provides a more stable system, as well as a system that is more resilient to interference with the environment which ultimately raises the quality and stability of services to a new level of highest standards.

GPON architecture

Gigabit Passive Optical Network (GPON) is currently one of the fastest growing access technologies on the market. GPON evolution and standardisation offers new opportunities that will support future broadband access networks and services. The trend of establishing access networks on wavelength-division multiplexing (WDM) will enable a new generation of optical broadband access in the near future.

It is estimated that today, private users' data communication needs go up to 100 Mbps downstream and 30 Mbps upstream. The demands mainly come from triple play services that combine voice, data and video transmission. New services such as Video on Demand (VoD), interactive

IPTV, HDTV (High Definition Television), 3D TV, videoconference systems for many participants, telemedicine and other applications that require a more significant bandwidth capacity will definitely become the main incentive for developing the next generation of access networks that will satisfy the ever growing demands in terms of transmission speed. Estimates that there will be a demand for 1Gbps speed per household in the near future are quite realistic. Furthermore, there are ever growing demands for symmetry (downstream and upstream). The prevailing, present solutions for broadband access networks are networks based on a Digital Subscriber Line (DSL) and cable television (CATV).

However, both technologies have limitations because they are based on the infrastructure primarily intended for transmitting voice and analogue TV signal. Considering the limitations of the existing copper pairs, it is impossible to assign a DSL technology to all pairs in a cable because, in such a scenario, mutual harmful influences (the so called crosstalk) between the pairs in a cable would be too great and would additionally limit the range and quality of transmission. Due to network saturation, not all users are able to have the same broadband internet access and IP television service quality, and certain copper pairs do not even support the stated services. In the following period, it is expected that the operators will invest in optical access infrastructure with the goal of satisfying the users' needs, i.e. so as to be able to offer a wide spectrum of services such as transmission of a multi-channel HDTV, Video on Demand and videoconferences, as well as voice transmission services via the Voice over Internet Protocol (VoIP).

It is estimated that, in the next couple of years, the world will see a significant increase in the number of Passive Optical Networks (PON) alongside the GPON (Gigabit Passive Optical Network) system domination as an optical access technology. GPON supports the highest transmission speeds and a wide range of applications and services, and it is especially suitable for video and TV services. GPON can be applied in different network architectures, combined with VDSL2 (Very high speed Digital Subscriber Line) in the FTTC architecture (Fibre to the Curb), or in the FTTH architecture (Fibre to the Home) for a residential access. However, even the existing optical access networks have limitations in terms of a guaranteed bandwidth and service quality, so, in the near future, they will not be able to satisfy the ever growing capacity demands for the upcoming services. That is why it is important to define a simple and efficient evolutionary track from the existing PON systems towards the next generation of PON systems without significant changes in the installed optical infrastructure. GPON evolution offers new opportunities for future broadband access networks and services.

The following step in GPON evolution is an increase in the transmission speed from the current 2.4 Gbps to 10 Gbps downstream, and from 1.2 Gbps to 2.4 Gbps upstream. The general characteristics of passive optical networks is the absence of active components in the distribution network. Optical Line Termination (OLT) is an active component placed in the central office CO-HUB (Image 1 and 2), while Optical Network Units (ONU) or Optical Network Terminals (ONT) are placed with the user.

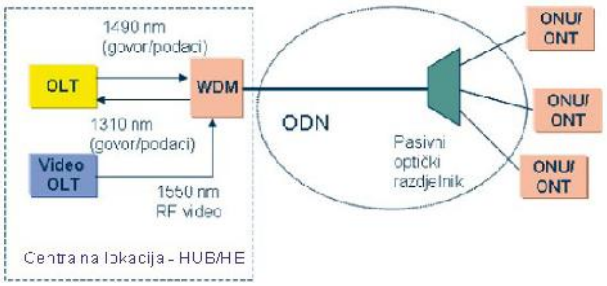

Image 1

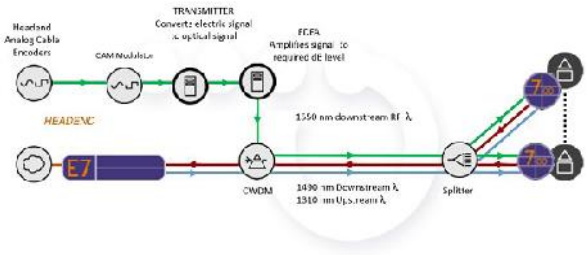

Image 2

The primary advantage of using passive optical networks in Point-to-Point Fibre Optic Links lies in savings when building cable infrastructure, because the PON usage decreases the necessary amount of optical threads/fibres.

The signal strength transmitted to end users is divided in the ratio of 1:N were N equals the number of end users connected to the passive optical splitter.

Optical splitters can be placed near the OLT or closer to the end users depending on the availability of optical infrastructure or the PON implementation strategy. In general, passive optical networks are based upon three network topologies: FTTH (Fibre To The Home), FTTB (Fibre To The Building) and FTTC (Fibre To The Curb) (Image 3).

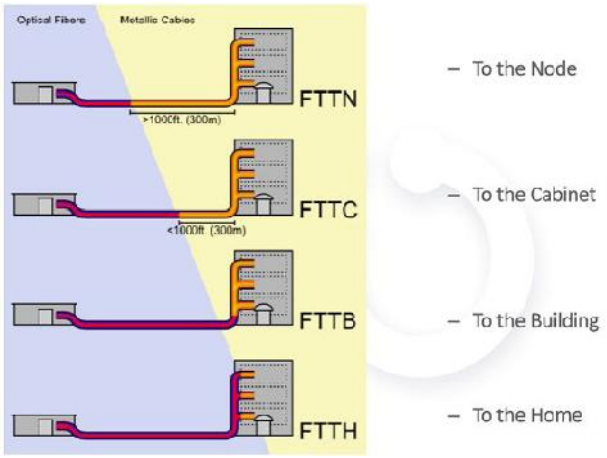

Image 3

Image 4

This process is called ranging. The OLT unit determines the time slot in which its assigned unit ONU/ONT will transmit its information. Ranging is performed during the activation of optical units ONU/ONT, and it can also be performed during operations. One of the greatest advantages of PON is the fact that it can support different transmission speeds and different services without changing the optical components between the central office CO/HUB and the subscriber's end devices. This represents a simple solution for the Optical Distribution Network (ODN).

Conclusion

Apart from improving the quality of telecommunications services, increasing data flow and information access speeds both towards the users and from the users towards world networks, additional safety from interception at the physical layer of communication as opposed to the physical layer essentially made from precious metals, the widespread networks are additionally significant from the environmental aspect. All passive optical networks without active components that do not need a power supply provide an additional contribution to savings in terms of usage and exploitation of fossil fuel and decrease the production of different metals, electronic components and other products that require special conditions for exploitation and recycling. GPON networks directly replace large amounts of cables made from precious metals that, apart from the function they perform in transmitting a signal, can present a danger in case of undesirable atmospheric discharge, or a direct contact with electrical grids of different voltage levels, and even inductive dangerous impulses due to their vicinity, which is not the case with optical cables in GPON networks.

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Primjenjena fizika u tehnologiji GPON mreža...novo vrijeme telekomunikacija

SAŽETAK

Pojava potrebe za pristup brzom internetu, kao i drugim servisima, u oblasti telekomunikacija, nametnula je primjene multipleksiranja kanala i realizaciju širokopojasnih mreža. Cijela industrija kablovskih sistema u svijetu je već bila na zavidnom nivou, tako da su operateri u okruženju mogli vrlo jednostavno doći do tehničkih rješenja naravno uz dobru finansijsku potporu. Sa vremenom, operateri shvataju ozbiljnost i mogućnost usluga pa počinju da uvode profesionalnu opremu renomiranih proizvođača instalirajući potpuno novu infrastrukturu daleko boljih tehničkih karakteristika ugrađujući širokopojasnu aktivnu opremu koja omogućava izgradnju velike i kvalitetne infrastrukture. Ovakve mreže počinju se graditi primjenom logike HFC konfiguracija. U cijelu infrastrukturu ugrađuju se i pasivne komponente sistema sa potpuno novim tenhičkim karakteristikama što doprinosi kvalitetu usluga.

Ključne riječi: Internet, GPON mreže, sistemi.

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